

06/21/01

Extrapolation of Spacecraft Vibration Test Data

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A current challenge is the development of integrated test and analysis methods for capturing the knowledge gained in ground and flight dynamic tests and for carrying forward this knowledge to the benefit of new designs. Hybrid modeling tools are needed to extrapolate: 1) the results of development tests to flight hardware configurations, 2) the results of flight hardware ground verification tests to flight conditions, and 3) the results of flight tests to candidate new designs.

The following hybrid extrapolation method is being investigated at JPL in conjunction with a current NASA headquarters RTOP and the Mars Exploration Rover (MER) project. This approach is an adaptation of the modal mass acceleration curve (MMAC) currently used at JPL to characterize the dynamic excitation of spacecraft by different launch vehicles. The MMAC is a plot of the maximum acceleration of each vibration mode on the ordinate versus the effective mass of that mode plotted on the abscissa. (The modal effective mass is a very special and powerful normalization method developed at JPL in the '70s. The sum of the modal effective masses is the total mass.) The power of the MMAC approach is that an FEM may be used to extend the results of the MMAC to predict the maximum response of any point on the structure!